Clustering and feature selection methods for interplanetary space trajectory optimization

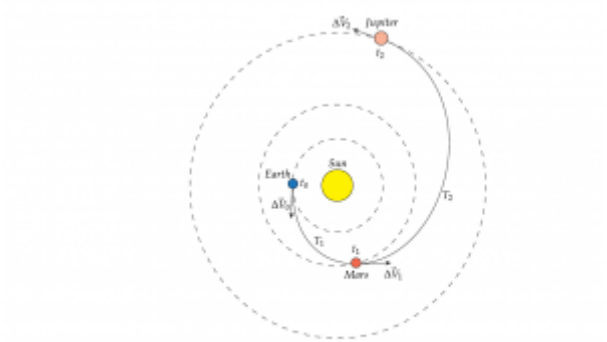

FIGURE 1.6: MGA problem with planet sequence Earth-Mars-Jupiter

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Planning the optimal trajectory of an interplanetary space mission allows to save large amounts of fuel and time. Such a task can be modelled as a constrained global optimization problem. However, solving the resulting model is extremely hard, due to the many suboptimal trajectories that can be built.

Moreover, the cost of a solution is highly sensitive to changes in the variables' setting. Perturbation-based approaches such as Monotonic Basin Hopping, despite being very effective in locating the global optimum, are known to be computationally expensive.

Clustering methods such as Multi-Level Single-Linkage (MLSL) group solutions around their regions of attraction, and start an expensive local search only from the best members of each group. This strategy allows to focus the computational effort on the most promising configurations, avoiding redundancy. However, despite an initial success, these methods have been progressively abandoned, as their clustering phase fails when the problem dimension is large. This happens because they

group solutions based solely on the value of their variables, which is likely to be a bad descriptor.
In this work, MLSL is combined with a feature selection strategy. This way, only the most descriptive variables are used to characterize trajectories when they are compared and clustered. Such a design choice makes the grouping phase of MLSL sharper, and allows to achieve the same effectiveness (that is, solution quality) of a perturbation-based method while employing a tiny fraction of local searches.

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